



# ITI 2000

## How Wireless Systems Work

## Wireless in Tribal Lands

- Because of geographic isolation, wireless technologies may be the most cost-effective telecommunications solution
  - Wireless networks are free of many of the installation and maintenance costs incurred with wireline networks
  - Unlike a wireline network in which an entire market must be wired before initiating service, the capital expenditures of a wireless network can be incrementally incurred as more customers are added
  - Existing wireless networks can be expanded or redesigned to provide additional services



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## Recent FCC Actions

- FCC has been exploring ways to encourage use of wireless technology in underserved areas
- Most recently, the FCC has adopted rules that provide incentives for wireless telecommunications carriers to serve individuals living on tribal lands. These rules provide for:
  - New Bidding Credits in future spectrum auctions
  - Possible waivers of technical or operational rules
  - Reconsideration of spectrum license areas



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## Wireless Technology

- Can be mobile (from a car or pedestrian) or fixed (from a house or office)
- Can be used for voice or data, such as wireless Internet



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## Services and Providers

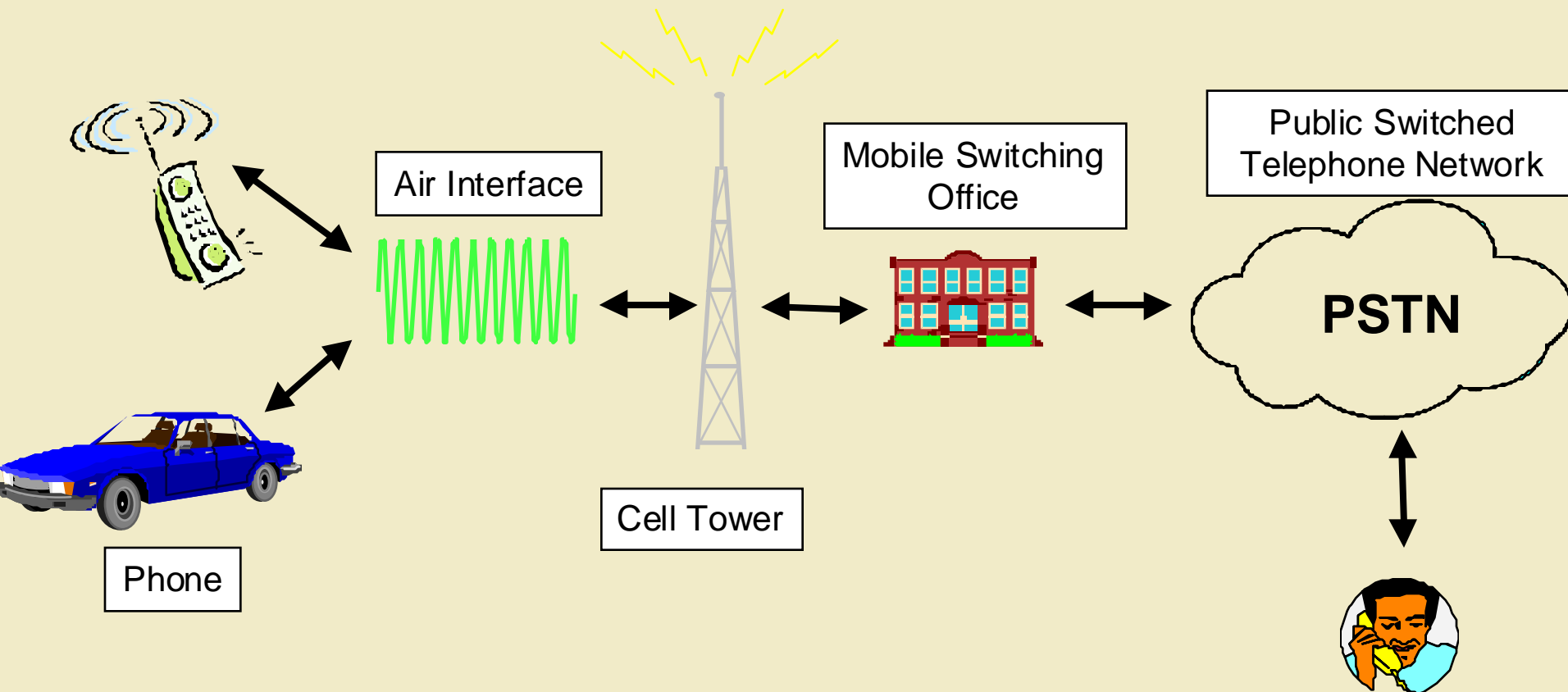
- Mobile Telephony
  - Commonly called cell phones
  - AT&T Wireless, SBC-BellSouth, Sprint, Verizon (Combined Bell Atlantic, GTE, and Vodaphone/ Airtouch), Voicestream, Nextel, ALLTEL, US Cellular
- Fixed Wireless
  - Wireless Local Loop (WLL) - replacement of local wireline access
    - AT&T, few small trials
  - Business high-speed access
    - Teligent, WinStar, NEXTLINK

## Services and Providers (cont.)

- Mobile Data
  - Mobile data service is the delivery of non-voice information to a mobile device
  - Most major voice carriers offer some form of internet access
- Dispatch - specialized type of mobile voice
  - Typical users include taxicab and delivery companies whose operations require their employees to communicate with each other on a private (one-to-one) or group (one-to-many) basis.

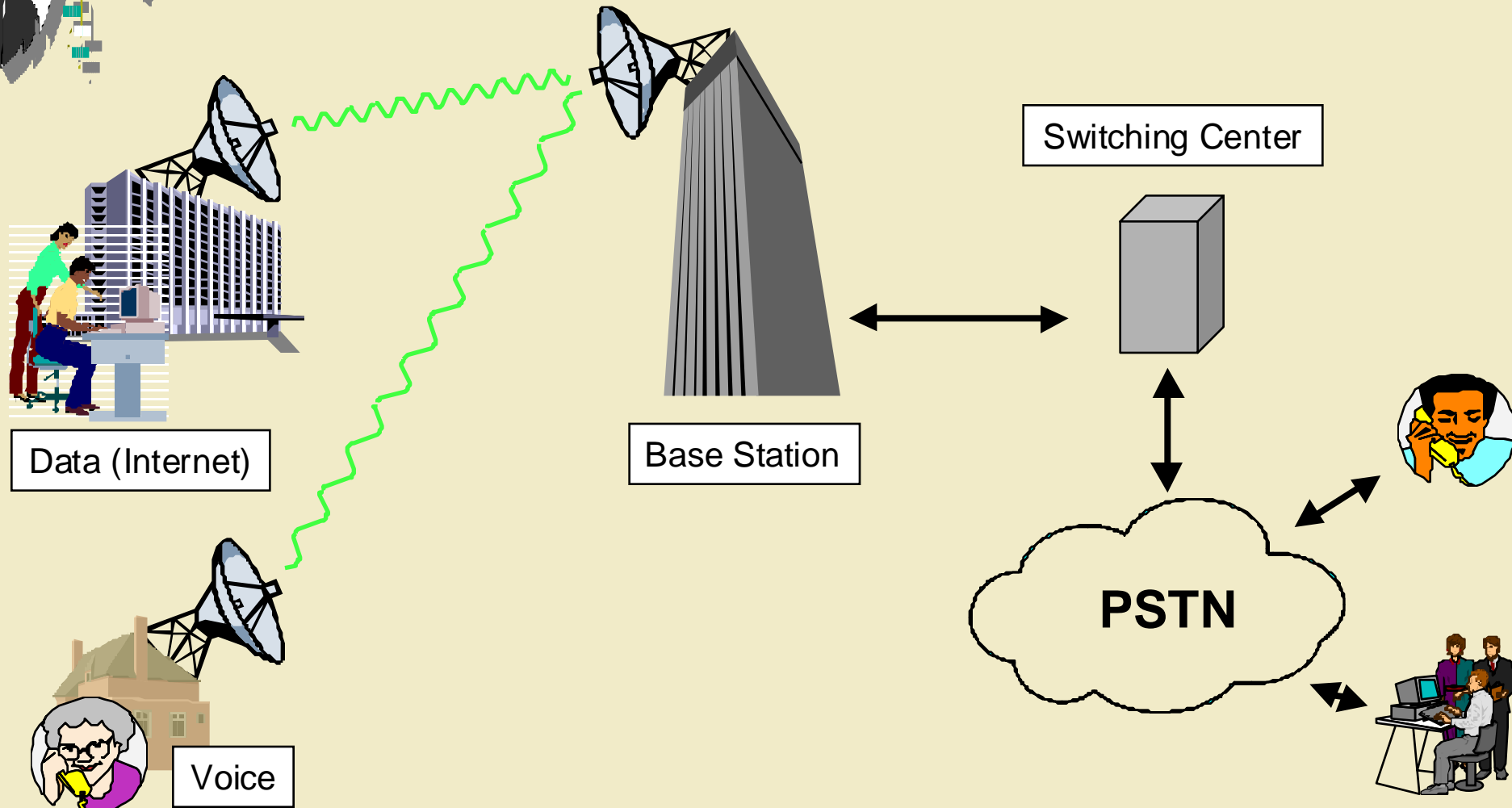
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## How to Make a “Wireless” Phone Call



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## Fixed Wireless Networks







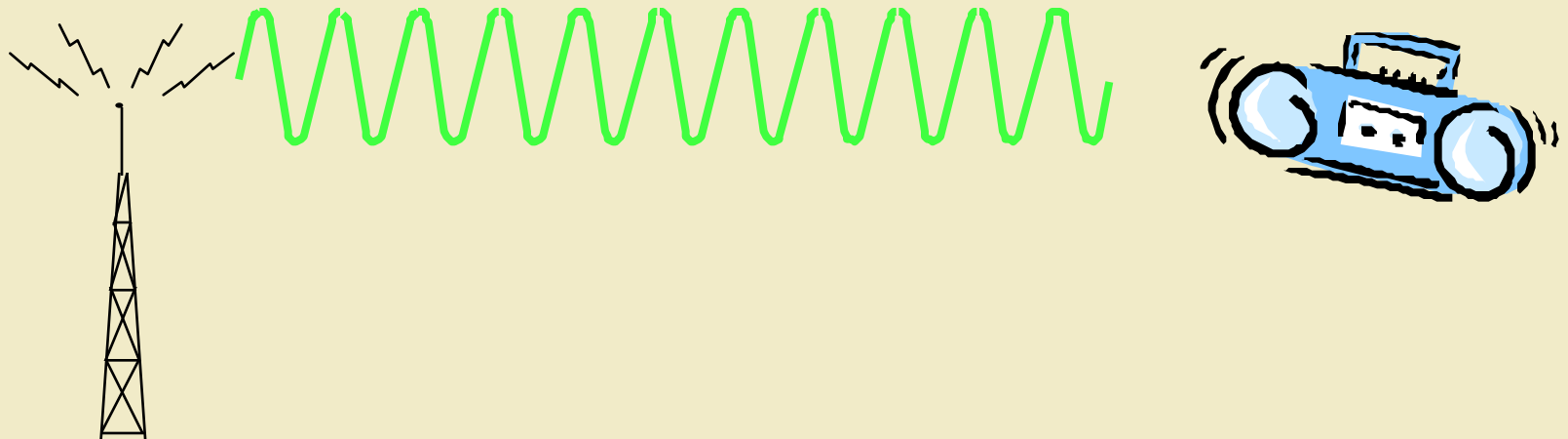
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## Scientific Terms and Concepts Behind Wireless Telecommunications



## Electromagnetic (EM) Radiation

- A natural phenomenon that allows information to be carried from transmitter to a receiver via a medium such as the air or fiber optic cable





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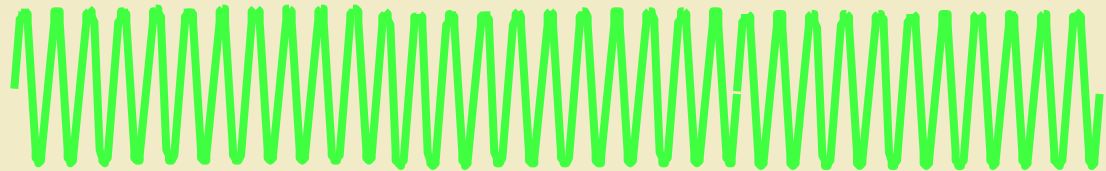
## EM Radiation

- Includes such effects as gamma radiation, X-rays, ultraviolet, visible, infrared, radar and radio waves
- We use radio waves for telecommunications



## EM Waves

- Wireless devices, such as cell phones, produce electromagnetic waves of different frequencies that move through space





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## Basic Wireless Terms

- Spectrum
- Frequency
- Bandwidth
- Capacity



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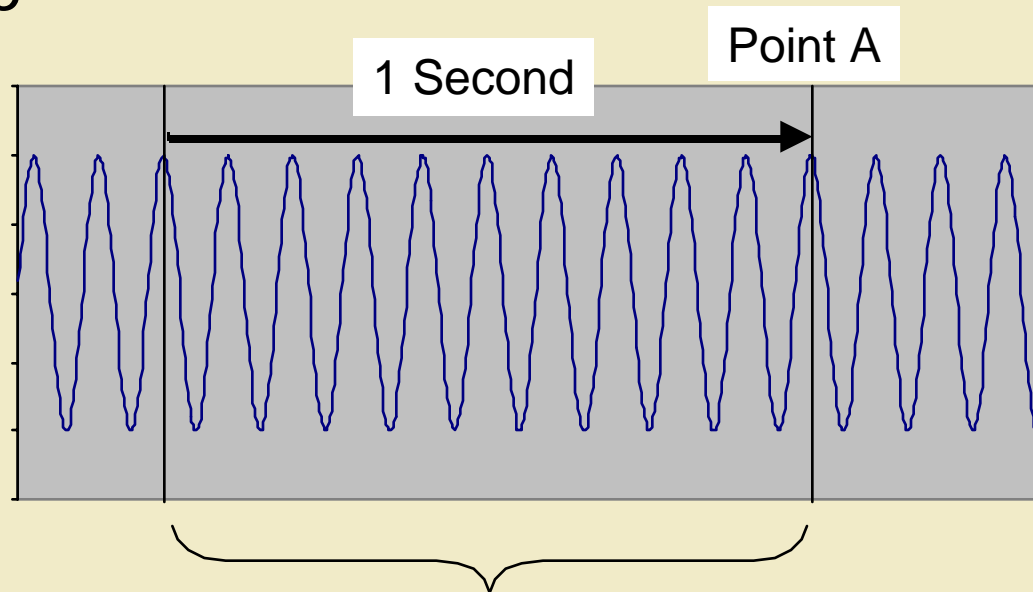
## What is Spectrum?

- For our purposes, spectrum is the term that describes a set of radio waves that can be used to transmit information



## Frequency

- Frequency is the number of times that a wave's peak passes a fixed point in a specific period of time



$$10 \text{ Cycles} / 1 \text{ Second} = 10 \text{ Hertz}$$



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## Frequency (cont.)

- Frequency is measured in cycles per second, or Hertz (Hz)

$1,000 \text{ Hz} = 1 \text{ KiloHertz (kHz)}$
$1,000,000 \text{ Hz} = 1 \text{ MegaHertz (MHz)}$
$1,000,000,000 \text{ Hz} = 1 \text{ GigaHertz (GHz)}$

- Cellular phones, for example, produce radio waves with frequencies around 800 million Hz (800 MHz)
- “Frequency” and “Spectrum” are often used interchangeably, although they are not the same



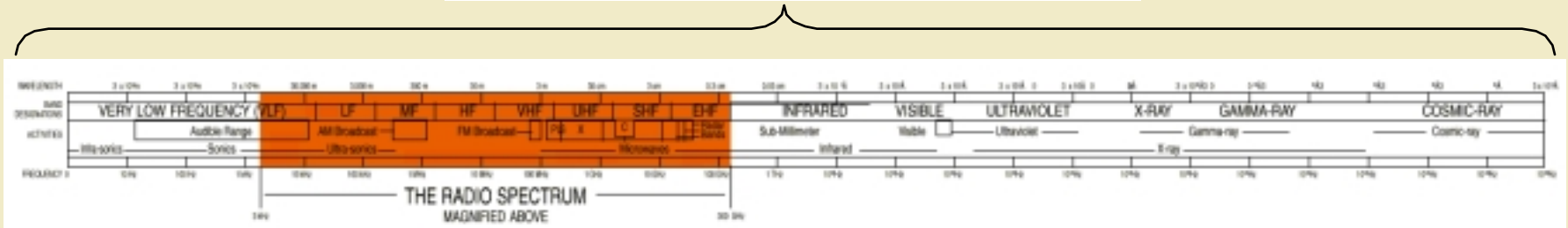


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## Electromagnetic Spectrum

- The set of all possible frequencies (an infinite number) is called the "**electromagnetic spectrum**"
- The subset of frequencies from 3,000 cycles per second to 300 billion cycles per second is known as the "**radio spectrum**"

## Electromagnetic Spectrum







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## Services with Related Spectrum

Service	Spectrum
AM Radio	535-1705 KHz
TV	54-88 MHz
Cellular (mobile services)	825-894 MHz
PCS (mobile services)	1.8-2.0 GHz
MMDS (fixed services)	2.1-2.7 GHz
LMDS (fixed services)	27-32 GHz



## Frequency vs. Bandwidth

- Frequency is a specific location on the electromagnetic spectrum
- Bandwidth is the range between two frequencies
  - Bandwidth is measured in Hertz
  - A cellular operator may transmit signals between 824-849 MHz, for a total bandwidth of 25 MHz



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## Bandwidth vs. Capacity

- Bandwidth for a particular service is fixed, but the number of calls and the rate of data transmission is not (capacity)
- The technology used determines the capacity of a particular bandwidth



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## Signal Strength

- The ability of an electromagnetic wave to persist as it radiates out from its transmitter
- Signal strength, or power, is measured in Watts, or more conveniently expressed in decibels (dB)



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## Power and Interference

- Power can increase the strength of a signal, but it can also cause the signal to “bleed” into other frequencies, resulting in interference with other transmissions



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## Path Loss (Path Attenuation)

- Decrease in signal strength over distance due to:
  - Absorption
  - Reflection
  - Diffusion
  - Scattering
  - Free-space loss





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## Lower Frequencies Are More Desirable

- Better for mobile services
  - Low powered signals go farther at lower frequencies, resulting in
    - lower-powered handsets = smaller handsets
    - Fewer cells



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## Higher Frequencies

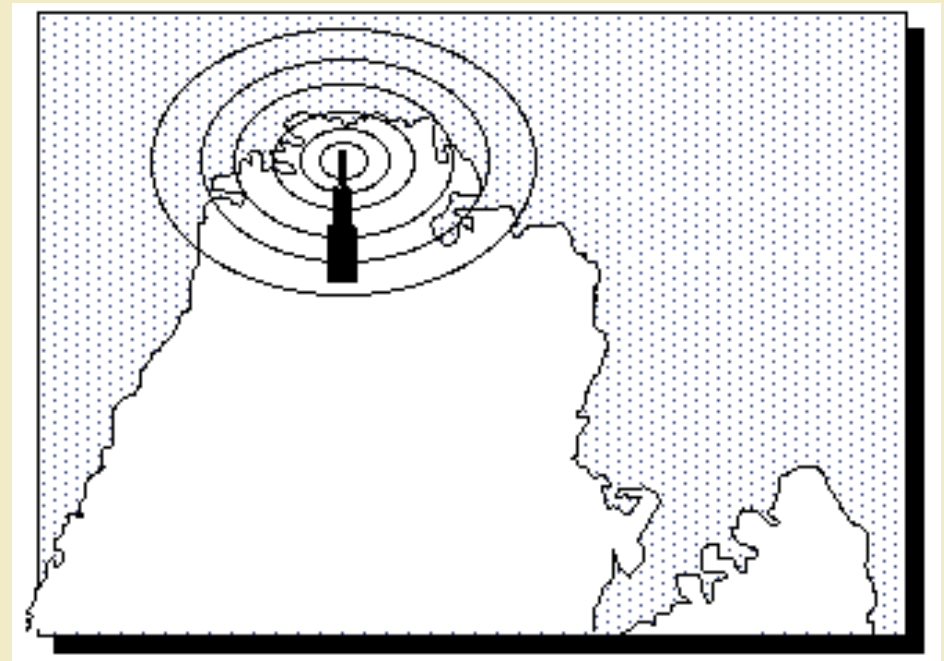
- Path Loss is greater at higher frequencies
- Higher frequency signals have difficulty penetrating buildings and traveling around objects
- Radio components are more expensive for higher frequencies
- Frequency stability (staying in your allocated bandwidth) more difficult at higher frequencies



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## Pre-Cellular

- One Transmitter
- High Power
- Limited Channels



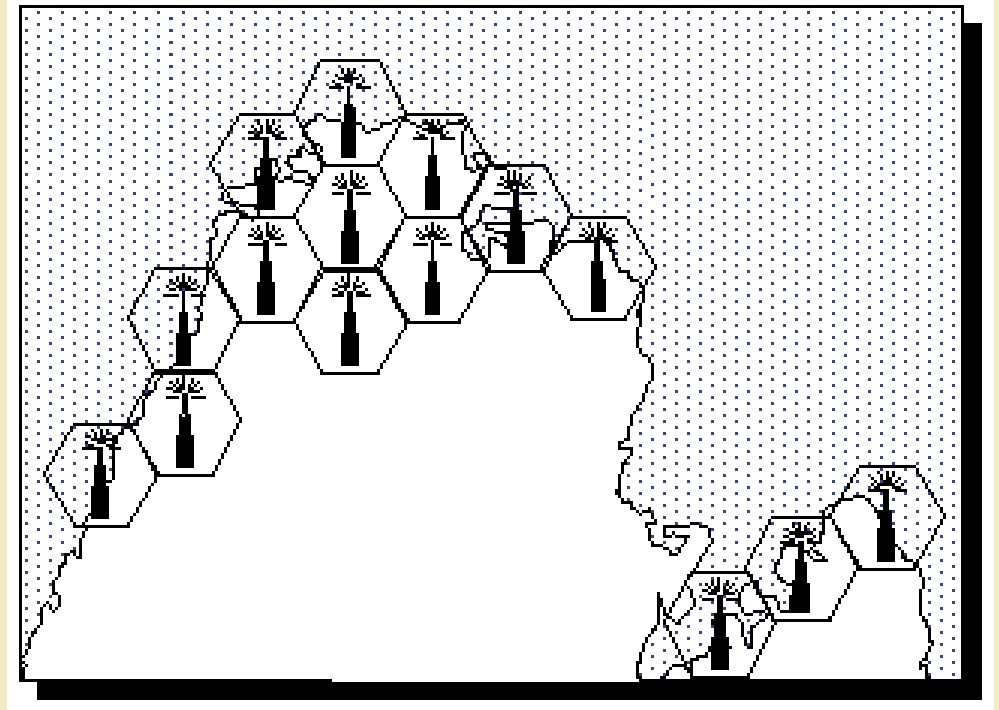
Source: International Engineering Consortium



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## Cellular Architecture

- Many Transmitters
- Low Power
- Frequency Reuse

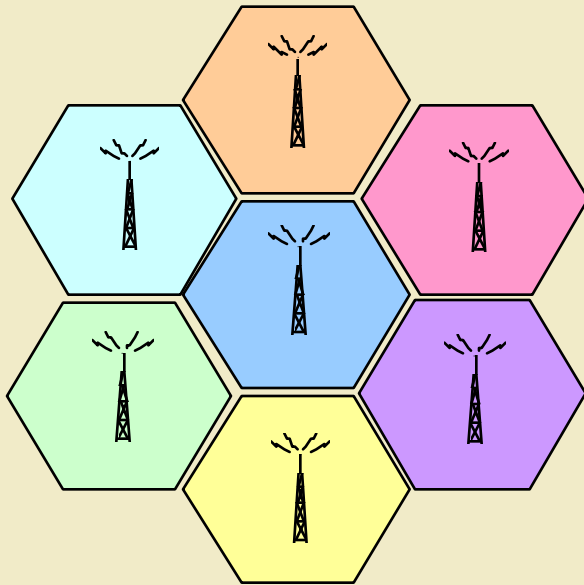


Source: International Engineering Consortium



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## Cellular Architecture (cont.)



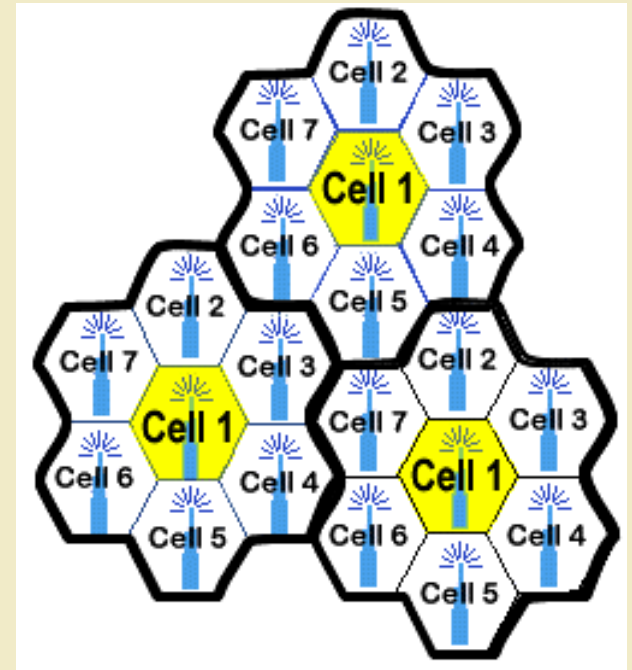
- Each tower serves one cell
- Each cell uses different frequencies
- As phone moves from one cell to another, towers “handoff” calls



## Frequency Reuse

Cellular networks are designed so adjacent cells use different frequencies

### Seven-Way Frequency Reuse



Source: International Engineering Consortium



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## Digital Technology

- Significant improvement in wireless systems
- Transfers information in digital format (binary 0's and 1's) versus analog (continuous values)
- Reduces many problems associated with decrease in signal strength



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Digital is better

- Improved Signal Quality
- Enhanced Features
- Improved Security
- Increased Capacity
- Extended Battery Life





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## Cellular Licenses vs. Cellular Phone Systems

- All mobile telephony providers use “cellular” architecture
- Primarily two different types of FCC licenses are used to provide mobile telephony: Cellular and PCS (Personal Communications System)



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## Cellular vs. PCS

	Cellular Licensees	PCS Licenses
Spectrum	850 MHz	1.9 GHz
Bandwidth	2x25 MHz licenses	3x30 MHz licenses 3x10 MHz licenses
Introduction	1980's	1990's
Format	Originally Analog	Originally Digital



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## Competing Air Interface Technologies

- **Analog**
  - **AMPS (Advanced Mobile Phone System)**
  - First cellular standard, used by all cellular licensees
- **Digital**
  - **TDMA (Time Division Multiple Access)**
    - AT&T
  - **CDMA (Code Division Multiple Access)**
    - Sprint, Verizon
  - **GSM (Global System for Mobile Communications)**
    - Voicestream, Most European Operators
  - **iDEN (Integrated Digital Enhanced Network)**
    - Uses SMR licenses rather than cellular or PCS
    - Nextel



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## Air Interface Development

- **1st Generation (1G)**
  - Represented pioneer analog cellular systems that permitted two-way voice communications, circuit-switched data transmission
- **2nd Generation (2G)**
  - GSM, TDMA, and CDMA
  - 2G networks are the first digital mobile telephone networks and offer voice services such as voice mail and caller ID as well as Short Messaging Service (SMS)
  - Data speeds of 9.6 to 19.2 kbps
- **3rd Generation (3G)**
  - Currently in development
  - 3G technology promises Internet access with speeds up to 2 Mbps
  - Planned 3G services include video and audio streaming and location-based services



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## EXTENDING WIRELESS TELECOMMUNICATIONS SERVICES TO TRIBAL LANDS, *Report And Order And Further Notice Of Proposed Rule Making* (rel. June 30, 2000), FCC 00-209.

- **Tribal Lands Bidding Credits:** Established bidding credits that will be available in future auctions in markets that contain qualifying tribal areas that have a telephone service penetration rate below 70 percent
- **Waivers:** The FCC stated that it will work with tribal authorities and carriers in instances where waivers or other relief from regulatory requirements would assist their efforts to promote deployment of wireless services on tribal lands
- **License Areas:** The FCC will consider tribal land boundaries in defining licensing areas for future services
- In the **Further Notice of Proposed Rulemaking**, the FCC seeks comment on:
  - whether to award transferable credits for use in future auctions to licensees in already-established wireless services who deploy facilities and provide service to unserved tribal communities
  - whether to make credits available to licensees that enter into partitioning agreements with tribal authorities



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## Wireless Trade Associations

- Cellular Telecommunications Industry Association (CTIA)
- Personal Communications Industry Association (PCIA)
- Telecommunications Industry Association (TIA)
- American Mobile Telecommunications Association (AMTA)



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## To Learn More . . .

- Visit the Exhibit Hall
- Surf the 'Net in the Internet Café
- Attend “Ask an Expert about Wireless and Satellites” workshops
  - Tuesday afternoon
  - Thursday morning

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